Improving Water Management at Belgorod-Dnestrovsky Water Utility

Project Title: Systematic Approach to Improved Water Quality and Rational Water Consumption in Belgorod-Dnestrovsky City
Project Leader: Belgorod-Dnestrovsky Water Utility, Belgorod-Dnestrovsky, Ukraine
Project Partners: Enviros, Prague, Czech Republic; CENTURY-XXI, Ltd., Kiev, Ukraine
Project Associate: Pavoda/ Hydroprojekt, Prague, Czech Republic
Location of Project: Belgorod-Dnestrovsky, Ukraine
Project Duration: February 2002 - December 2002
EcoLinks Project Contribution: Total Project Investment: $65,640; EcoLinks Grant Support: $47,612 Project Team Cost-share Contribution: $18,028.

Best Practice: Transferable Solutions

The project "Improving Water Management at Belgorod-Dnevstrovsky Water Utility" is an EcoLinks Best Practice. Through this EcoLinks funded project, the water utility of Belgorod-Dnevstrovsky city teamed up with the Czech consulting firm, Enviros, to identify options for improving water and sewage management. The feasibility study and Action Plan developed through this project provide a blueprint for reducing water consumption by 33%, energy consumption by 39% and improving water and sewage discharge quality within the Belgorod-Dnevstrovsky network. The methodology applied in this project for conducting energy and environmental audits, for conducting a water balance, and developing a feasibility study are highly transferable to other water utilities in the region.

Project Summary

Belgorod-Dnesvstrovsky Water Utility (BDWU) supplies drinking water and sewage collection and treatment services to residential and commercial customers in the city of Belgorod-Dnestrovsky (population 55,000). Due to water shortages and mismanagement of water resources, BDWU is able to provide drinking water to consumers only intermittently: for four hours during the morning and four hours during the evening. Much of BDWU's infrastructure was constructed in the 1950's and is in extremely poor repair, resulting in large water and energy losses (project findings showed that about 38% of treated drinking water is lost in the distribution network, before ever reaching the customer).

The goal of this project was to identify options for improving water and sewage management within the Belgorod-Dnevstrovsky Utility network. The Project Team began by conducting an environmental and energy audit of the water supply network and sewage treatment system. This was followed by calculating the water balance in the drinking water transport system and estimating consumer demand and operational costs for the system. Based these findings, the Project Team developed a feasibility study which considered the environmental and economic attractiveness of improvement options under different economic and growth scenarios. An Action Plan, outlining major recommended efficiency and water quality measures, their costs, benefits and potential funding sources, was developed and presented to the Odessa Regional and Belgorod-Dnevstrovsky City Councils and to other utility service providers. The recommendations outlined in the Action Plan provide a blueprint for reducing water consumption by 33%, reducing energy consumption by 39%, and improving water and sewage discharge quality.

Project Activities

The main goal of this project was to identify options for improving water and sewage management within the Belgorod-Dnevstrovsky Utility network. Project Activities included the following:

1. Environmental Audit of Belgorod-Dnestrovsky Water Supply and Network
Action: The project team conducted an environmental audit of the Belgorod-Dnestrovsky water supply and network. This audit considered both the quality of raw water resources (water quality tested against EU and Ukrainian water quality standards for coloring, turbidity, oxidation, ammonia, chlorides and dry residues) and the physical condition of the infrastructure of the network itself.

The main findings of the audit are provided below.

<u>Findings on Raw Water Resources:</u>
Drinking water to the city of Belgorod-Dnestrovsky is supplied from two sources: (1) local artesian wells, which provide about 40% of all drinking water; and (2) treated water, pumped from the Dnestr Water Treatment Plant. The main findings of the environmental audit show that:

- Water from the artesian wells does not meet all of Ukrainian and EU water quality parameters. Increasing levels of chlorides and hydric sulfide and high levels of ammonia nitrogen and bacterial contamination are particularly worrying. Management and

protection of the wells are insufficient: the wells are located within city limits and are not sufficiently protected, which could lead to contamination of the wells.
- Water from the Dnestr Water Treatment Plant, though highly chlorinated (due to the high bacterial content in the Dnestr river), in general meets drinking water quality standards. The 40-km transport pipeline from the Dnestr plant to the city of Belgorod-Dnestrovsky presents a potential source of iron contamination.

Findings on Water Infrastructure Network

Drinking water from the Dnestr Water Treatment Plant is pumped through pressure conduits. The conduit to Belgorod-Dnesrovsky is a 40-km long pipe system. Drinking water from artesian wells is pumped from the wells to one of three pumping stations and mixed with water from the Dnestr Water Treatment Plant. Within the town of Belgorod-Dnestrovsky, water is pumped through a local supply network 142 km long; about 80% of this system was constructed during the 1950's.

The main findings of the environmental audit on the infrastructure network show that the entire supply and pumping network is in very poor condition. Specifically (1) wells are not sufficiently protected; (2) the main supply pipeline from the Dnestr Water Treatment Plant to Belgorod Dnestrovsky is in abysmal condition and is the cause of many disruptions in water supply; (3) piping in buildings and equipment at pumping stations are in extreamly poor repair; (4) chlorinating units are out of date and do not meet safety codes; (5) electrical equipment (mainly pumps) throughout the system does not meet safety codes, and in many cases is over-sized; (6) water distribution networks within the town of Belgorod-Dnestrovsky are out of date and the source of large water losses. In total, findings of the audit showed that an estimated 34-40% of treated water is lost within the system; additional losses also occur in end-user buildings.

Product(s): 1) Environmental audit of water supply and network and identification of areas for further consideration during development of feasibility study (Activity # 5).

2. Environmental Audit of Belgorod-Dnestrovsky Sewage Treatment System

The Project Team conducted an environmental audit of each step in the sewage collection (sewage collection from customers, sewage reservoir, and transport system to treatment station) and treatment system (pre-aerators, air-mixer tank, secondary sedimentation tanks, sludge catcher, concentration take, discharge header, pumping station, chlorinating-unit). Wastewater discharge was also considered. Results of the audit showed that the sewage treatment plant is outdated and that discharged wastewater quality fluctuates significantly and sometimes exceeds permissible standards.

BDWU sewage treatment facilities receive sewage from residential and industrial customers. Sewage is gathered from three district sewage pumping stations, and from there pumped to the main treatment plant. The sewage collection network is about 20 km long and was constructed in 1971. Pipes and pumps in the network have not been replaced since they were installed and are currently in extremely poor condition.

Sewage treatment is conducted through biological aerobic treatment, chlorine and sedimentation ponds. Final treated wastewater is drained into the Dnestrovsky Estuary. Current capacity of the city sewage treatment is $10 m^3$/day, which covers city needs. However, maintenance of the system has not been carried out since 1992 and the facilities are

in poor repair and obsolete. A 17-hour power outage in 2000 disturbed the biological treatment processes in the system and resulted in problems in the system for six weeks.

Product(s) Environmental audit of the BDWU sewage collection and treatment system and identification of areas for further consideration during development of feasibility study (Activity # 5).

3. Energy Audit of Belgorod-Dnestrovsky Water Supply Network and Sewage Network
The Project Team began this activity by conducting a walk-through audit to determine the general energy supply to and demands of the BDWU. Following the walk-through audit, a thorough audit of the technological processes in the sewage treatment plant, the buildings of the utility and pumping facilities (both drinking water and sewage water) was conducted. Findings of the audit showed that energy costs make up 27% of total water supply operating costs and 28% of total sewage treatment operating costs. Most of this is electric power (89%) --mainly for pumps-- and the rest coal heat.

The following were identified as potential areas of energy savings, to be further studied under the feasibility study: (1) level of insulation in heated buildings/rooms; (2) potential capture and use of biogas from sewer water treatment processes; (3) potential use of heat pumps for space and water heating in administrative buildings; (4) potential energy savings through properly sized electric motors and pumps.

Product(s): Energy audit

4. Estimation of Water Balance, Consumer Demand and Economic Operational Framework
Action: Enviros and CENTURY-XXI worked with BDWU employees to collect information on consumer demand and to train BDWU employees in methodologies for conducting a water balance and calculating leaks. Information on water consumption is collected for invoicing purposes by BDWU through meters placed on water mains and in apartment buildings. Findings from this activity showed that non-invoiced (lost through leaks or inaccurate recording) water makes up almost 40%.

The Project Team calculated BDWU's operational costs and income. These calculations showed that it is almost 50% less expensive to purchase treated water from the Dnestr Water Treatment Plant than for BDWU to pump, treat and supply water from artesian wells.

Water and sewer costs equal about \$0 .4 /m^3 to private households. However, the average income in Belgorod-Dnestrovsky is only about \$26.5/month. Due to the very low average monthly income, consumers in Belgorod-Dnestrovsky pay a much higher ratio of their earnings for water supply and sewage service than residents in Europe.

Product(s): (1) Water balance calculated; (2) BDWU's operational costs calculated; (3) Tariff system analyzed.

5. Development of a Feasibility Study on Options for Efficiency Improvements in the BDWU Water Supply and Sewage System
Action: Based on the findings of the environmental and economic audits, the Project Team considered the economic and environmental attractiveness of options for the BDWU water supply and sewage system under three different growth, subsequent water demand, and legal-

normative scenarios (conservative, progressive and high). The variants consider technical measures (construction and repair work), economic measures (pricing structure and invoicing) and management measures (optimization of system flow).

During this entire process, Enviros and CENTURY-XXI experts worked with employees of BDWU, training them in methodologies of cost-benefit analysis and feasibility study development.

Water Supply System;
Within the feasibility study, the Project Team developed and assessed five possible scenarios for the BDWU water supply system. Under the favored variant, the city will continue to be supplied with drinking water from artesian wells and the Dnestr Water Treatment Plant, while exploring new well resources.

The main recommended technical measures under the selected variant include developing protective zones for the artesian wells, building a new water supply-line from the Dnestr Water Treatment Plant, recycling treated sewage water for industrial purposes, rehabilitation of water mains and expanding service. Total cost of the recommended measures is $16.8 million, with payback periods ranging from one year to six years.

The main economic measures under the selected variant include improving the invoicing system for water use, monitoring the volume of water supplied to individual zones in the city to detect un-invoiced water losses, tariff modifications (introduction of progressive and seasonal tariffs), improvements in the collection of tariffs, and unifying payments for communal services (heat, water, electricity) into one database.

Recommended management measures under this variant include considering and adopting appropriate database and simulation models and real-time water management systems.

Sewage System:
The Project Team developed three possible scenarios for the BDWU sewage system. Under the favored variant, the most problematic aspects of the sewage system will be addressed through gradual repairs and up-grades, while moderately expanding the network to service an additional 9,000 customers.

The main recommended measures under this variant include rehabilitating critical sewage water treatment equipment (repair of existing air tank mixer and completion of secondary mixer), rehabilitating the sludge removal and processing system, repairing the chlorinating units, gravity headers, main inlet and outlet discharge headers, and pumping stations, expanding biological treatment ponds, recycling treated sewage water for industrial and irrigation purposes, and implementing a consistent sewage waste water monitoring program. The total cost of recommended measures is $4.64 million and payback periods of individual measures range from 1-15 years.

Energy Saving Measures
The Project Team developed three possible scenarios for energy savings within BDWU. Under the favored variant, urgent repair works will be carried out on air tank mixers and secondary sedimentation tanks.

Recommended measures under this variant include replacement of selected pumps and optimizing the pressure regime in the water supply system, low and medium cost efficiency improvements in buildings, installation of various autonomous heat systems (heat-pumps, power-hydraulic generators, etc.), and installation of solar collectors for hot water supply within administration buildings. The total cost of these measures is $.73 million and the measures have a payback period of between a few months and six years.

Product(s): 1) Feasibility study on efficiency improvements in the water supply, sewage system and on energy efficiency measures at BDWU. (2) BDWU staff trained in conducting a feasibility study.

6. Development of an Action Plan for Implementation of Measures Outlined in the Feasibility Study

Action: Based on the recommendations presented in the Feasibility Study, BDWU developed an Action Plan outlining major recommended efficiency and water quality measures, their costs, benefits, potential funding sources, potential beneficiaries and estimated timetable for implementation.

The Plan outlines 17 measures for improving water supply efficiency, with costs ranging from $1,000 to $25 million. The simple payback time of these measures is between two months and 10 years, with the exception of the three measures, which bring primarily environmental/ public heath benefits.

The Plan outlines fifteen measures for improving sewage treatment, with cost ranging from $5,000 to $8 million. The simple payback time for six of these measures is between one year and four years. Nine of the measures result primarily in environmental/ public health benefits.

The Plan outlines 10 measures for improving energy efficiency, with cost ranging from $400 to $40,000. The simple payback time of these measures ranges from three months to 12 years.

This Action Plan was presented at a seminar for Belgorod-Dnevstrovsky city government representatives and later at a seminar for city government and representatives of other utility companies in the region. The Project Team presented major findings of the project and next steps for implementation of the Action Plan. The seminars were covered by the local press.

Following the seminars, the Project Team met with the Regional City and Councils to discuss financing of specific measures. The Regional Council later contributed $95,000 in funding to reconstruct an air tank mixer and sedimentation tank in the sewage treatment plant.

Project Benefits

This project identified options for improving water and sewage management within the Belgorod-Dnevstrovsky Utility network. Through the project, the Leader's capacity to assess and quantify the economic and environmental costs of inefficiencies in the BDWU system and to evaluate potential improvement options was increased. The feasibility study and Action Plan developed through this project outline potential economic and environmental benefits. Theses include significant reductions in water consumption and in water losses, as

well as improved water quality. Electric energy consumption and corresponding emissions will also be significantly reduced.

Capacity Building Benefits
Through this project, the Leader's capacity to assess and quantify the economic and environmental costs of inefficiencies in the BDWU system and to evaluate potential improvement options was increased. Working with their Czech and Ukrainian partners, technical specialists from BDWU learned how to conduct energy and environmental audits, how to conduct a water balance and how to develop a feasibility study.

Environmental Benefits and Economic Benefits
The following environmental and economic benefits are based on improvement assumptions recommended in the feasibility study developed as part of this project.

(1) Reduction in electric energy consumption (and corresponding emissions) and costs by 39%
(2) Reduction in leaks and drinking water consumption by a total of 1/3. Corresponding reduction in drinking water treatment and distribution costs.
(3) Reduction in sewage over-flows and leakages
(4) Reduction of pollution concentrations in drinking water
(5) Reduction of pollution concentration in treated sewage water

Lessons Learned

Critical to the project's success was the active involvement and support of top management of BDWU as well as the support of the Regional Government. As a result of this support, the Project Leader is actively working with the Regional Government to find financial support to implement project recommendations. BDWU has already received about $95,000 in funding to reconstruct an air tank mixer and sedimentation tank in the sewage treatment plant.

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